The Multi-Stage History of Mt. Sharp

C. Allen[1] and A. Dapremont[2]

[1]Johnson Space Center, Houston, TX

[2]College of Charleston, Charleston, SC

The Curiosity rover is exploring Gale crater and Mt. Sharp, Gale's 5-km high central mound. We are investigating the history of alteration and erosion of Mt. Sharp using orbital imagery, spectroscopy and rover observations. Our results suggest a significant time gap between emplacement of the upper and lower sections of the mound.

Crater counts show that the lower mound was formed soon after Gale itself, and that it contains distinct units ranging in altitude from approximately -4,500 to -1,800 m. Spectral data suggest that many units contain phyllosilicates. We found that these clay-bearing rocks occur in distinct layers concentrated below -2,900 m. Parts of the lower mound exhibit a transition from clays to sulfates with increasing altitude. The lower mound shows evidence of flowing water, including canyons and inverted channels. Wind erosion produced km-scale yardangs and scalloped cliffs. Our mapping shows that many yardangs in the lower mound are clay-bearing, with a predominant orientation of around N-S.

Curiosity's ground-level images show myriad fine-scale, mainly horizontal layers in the lower mound. The rover has found stream beds and conglomerates, indicating that water once flowed on the crater floor. Drilling near the deepest point in Gale produced abundant clay, providing additional evidence of aqueous alteration.

Upper mound units range in altitude from -2,100 m to +500 m, and mantle the lower mound above an angular unconformity. Most upper mound units are composed of layers. The formation age of the upper mound is unknown, since few craters are preserved. Clay-bearing layers are detectable in several locations, mainly at altitudes near -2,000 m. There is no evidence of water flow, but wind erosion has scalloped the surfaces and edges of layers, and fine-scale yardangs are common. Correlations between yardangs and clay spectra are apparent only in the lowermost units of the upper mound. Yardang orientations vary, and include N-S, NW-SE, and NE-SW.

Upper mound units resemble the planet-wide Medusae Fossae formation, dated as Hesperian and argued to be composed of ignimbrites. Medusae Fossae layers are easily eroded by wind, and our mapping demonstrates their resemblance to upper mound fine-scale yardangs.

The history of Mt. Sharp started with deposition and lithification of sediments shortly after crater formation. Some lower mound layers were partially altered to clays and sulfates, and water formed streams and canyons. Wind erosion of the lower mound produced large-scale yardangs, particularly in clay-rich layers, oriented generally N-S. Upper mound units were emplaced following a considerable period of wind erosion. The absence of water flow on

the upper mound suggests that these units were emplaced after atmospheric loss rendered water unstable at the surface. The shift in dominant wind direction, as indicated by yardang orientations, also argues for a time gap between erosion of the lower and upper mound. These observations are consistent with upper mound units being related to the Hesperian Medusae Fossae formation.

During 2014 Curiosity is expected to reach the foot of Mt. Sharp and ascend through the clay-rich layers, into the sulfate-rich layers, and possibly past the interface with the upper mound. This will be a unique opportunity to field check geologic models on the surface of Mars.